High-Resolution, Real-Time-Geometry Video Acquisition System

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1 Introduction

"Can you capture the motion of a smile in 3-D?" This demonstration presents such a geometry video acquisition system that measures both geometries and positions of objects accurately. The data acquisition speed is 90 fps and over one quarter million points per frame. Acquisition, reconstruction, and display are simultaneously realized at 30 fps.

2 Applications

The geometric video acquisition system can be applied in many fields. One immediate application is 3-D modeling, for example, facial expressions modeling. Applications can be found in gaming. Since the acquisition, reconstruction, and display can be done in real-time, digitizing the player and putting his/her face into the virtual game world will be feasible in the near future. Another application is animation and movies, the real captured video data can be used in the animation world immediately. The system can also be applied to plastic surgery. Moreover, the same technology can be applied to homeland security. The geometry of the object overcomes many shortcomings of security checking techniques based on 2-D images, such as facial recognition, finger print, etc. Other applications include motion capture, fast prototyping, virtual reality, feature films, human computer interaction, industrial measurement, and inspection.

3 Exhibition

We will demonstrate our system at SIGGRAPH. Visitors sit in front of our system, we will capture their facial expressions in a few seconds, and generate the geometry video for them immediately. If they bring a flash drive, we can provide them with a copy of their data. Of course, if they have sculptures or other objects, we can scan and provide that data too. We believe it would be a great experience for the visitors to have geometric videos of their own faces.

4 Principle

[Zhang and Huang 2004; Zhang 2005; Zhang et al. 2004] developed 3-D scanning systems that could measure dynamic geometric shape. However, capturing the geometry video in absolute coordinates at 30 fps is very difficult for these systems. This demonstration presents an improved version of [Zhang 2005] system that overcomes shortcomings of the existing systems. It captures high-resolution absolute geometry videos in real time. The system is based on a structured light method. The coded patterns are sent to a DLP projector in B/W mode. A high-speed CCD camera synchronized with the projector is utilized to capture images at a speed of 90 fps. Since the acquisition speed is so fast, the process of geometric motion can be captured accurately. The system is able to obtain absolute coordinates, hence, the geometric shape and position changes can be measured accurately in real-time.

Due to the unique nature of the coding method, we demonstrated that the system can capture both geometric shape and position changes smoothly within a depth range of 700 mm. The system is robust to ambient light, surface reflectivity variations, color variations, etc. The measurement can be performed with extremely dark images, although the noise is larger. It is less sensitive to image defocusing. We successfully demonstrated that the system can measure hair, heavily bearded faces, dark faces, sweater with strong texture variations, and extremely blurred faces. Figure 1 shows a typical example of our measurement. Videos and additional examples are in the submitted video.

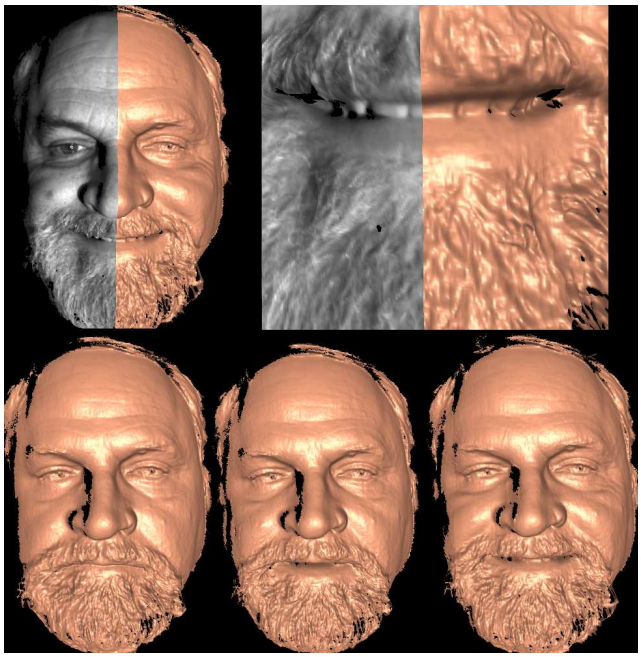

Figure 1: Geometric data captured by the system. Top row shows one frame, left image shows the geometry on the right side while texture on the left side; right image shows the close-up view of the left image near the mouth region. Bottom row shows three frames acquired in a sequence.

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